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Conference Paper

Competing through e-skills: Luxembourg and its second level digital divide

27th European Regional Conference of the International Telecommunications Society (ITS), Cambridge, United Kingdom, 7th - 9th September 2016

Provided in Cooperation with:

International Telecommunications Society (ITS)

Suggested Citation: Binsfeld, Nico; Whalley, Jason; Pugalis, Lee (2016) : Competing through e-skills: Luxembourg and its second level digital divide, 27th European Regional Conference of the International Telecommunications Society (ITS), Cambridge, United Kingdom, 7th - 9th September 2016

This Version is available at:

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Competing through e-skills: Luxembourg and its second level digital divide

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Abstract

There is growing awareness amongst policy makers, scholars and practitioners that the Information and Communication Technology (ICT) sector plays an important role in a country's economy and welfare. The ICT sector relies on highly performing technical infrastructures but also needs skilled people who are able to understand its complexities and are fully capable of making the best use of its potential.

In this article we present and discuss this tension for the case of Luxembourg, one of the smallest countries in the world whose economy is open and largely service driven. Although a lot of improvements have been made in recent years regarding its ICT infrastructure, Luxembourg performs poorly in international league tables with regards to e-skills or digital competences showing a tendency to a "second level digital divide" in terms of its ICT professionals.

Drawing on a prior study which mapped Luxembourg's ICT ecosystem, we conducted qualitative interviews with human resources managers that allowed us to identify the need for relevant ICT professional skills. By applying an e-competences framework, we have identified six different families of ICT jobs that are most demanded in Luxembourg as well as their underlying competences. We then present several policy initiatives that could address the challenges faced by Luxembourg. By doing so we provide a contribution in order to better understand the issues related to e-skills and digital competences in a small country. To the best of our knowledge this is the first study of this kind looking specifically into the e-skills situation in Luxembourg

Keywords: e-skills, digital divide, competences frameworks, Luxembourg, ICT

1. Introduction

There is an on-going debate amongst scholars, practitioners and policy makers about the importance of Information and Communications Technologies (ICT) for the sustainable development of Europe and its role in terms of competing with the US or Asia (Bughin et al., 2016). A crucial element in this discussion is the growing lack of ICT skills throughout almost all EU member states (European Schoolnet, 2015). Many, if not most, EU member states are facing a growing lack of e-skills and it is predicted that there will be an overall shortage of supply of about 800,000 ICT professionals in the EU by the year 2020 (European Schoolnet, 2015; Gareis et al., 2014; Hüsing, Korte, & Dashja, 2015).

In this paper, we examine this situation looking at the case of Luxembourg, one of the smallest EU member states. The ICT sector generates about 7% of Luxembourg's GDP and directly employs about 17,000 people (Luxembourg for Business, 2013a) distributed across nearly 1,800 companies. Successive governments have supported the development of the sector by stimulating investments in communication infrastructures and data centres (Binsfeld, Whalley, & Pugalis, 2015). This has allowed Luxembourg to improve its position in international league tables like, for example, the networked readiness index produced by the World Economic Forum (World Economic Forum, 2015). However, when looking into the details of such assessments it appears that not all of the underlying contributing factors have developed positively in recent years. Whereas Luxembourg is amongst the top performers in terms of telecommunications infrastructures and datacentres (Luxembourg for Business, 2014), it does not score very well in terms of e-skills. In particular, Luxembourg lacks ICT professionals and their associated digital competences. Luxembourg's country profile (European Commission, 2015b, 2015c) within the Digital Economy and Society Index (Mateus, 2015), shows that, whilst there are widespread basic digital skills available, there is a shortage of qualified ICT experts in Luxembourg. Thus "in 2014, 58.5% of enterprises which recruited or tried to recruit staff for jobs requiring ICT specialist skills reported problems in filling these positions, up from 52.8% in 2012. This is the second-highest figure in the EU" (European Commission, 2015c).

Furthermore, Luxembourg shows the lowest percentage of graduates in STEM (science, technology, engineering and mathematics) graduates with only 3.6 graduates in STEM per 1000 individuals compared to an average of 17 graduates per 1000 individuals across the EU level. Having said this, there is high demand as about 5.1 % of the working population are considered to be ICT specialists, which is amongst the highest demands within the EU (European Commission, 2015c). As can be expected, the lack of ICT specialists, combined with a high demand, leads to significant competition between different employers and to comparatively high salary levels for those possessing the required skills. Thus, for example, an experienced CIOs can earn as much as €250,000 per year - similar to salaries paid to CEOs - according to a recent study by recruitment specialists (Hays, 2016). However, this obviously has a negative impact on Luxembourg's productivity and international competitiveness (Thelen, 2014).

When looking at the Networked Readiness Index (NRI) (Baller, Dutta, & Lanvin, 2016; World Economic Forum, 2015), it can be seen that Luxembourg is performing particularly badly on aspects such as "quality of management and scientific education" where it ranks 39 of 143 countries, "tertiary education enrolment" (93rd), "E-participation" (54th) and "quality of maths and science education" (28th)¹. Similarly, the International Telecommunications Union looks

¹ The authors are also working on an article which discusses the lessons to be learned from NRI for Luxembourg in greater details.

at skills related aspects as part of its ICT Development Index (IDI), which is unfortunately only updated every 5 years (International Telecommunications Union, 2015). In 2015, Luxembourg ranked first worldwide in the “access” sub-index and 5th in the “use” sub-index, whilst it ranked only 80th in the “skills” sub-index, a position even worse than in 2010 when it was 73rd.

On the other hand, the EU commission (European Commission, 2014) confirms a growing demand for ICT professional skills but also finds that the country’s digital strategy (Gouvernement du Luxembourg, 2014) makes little reference to e-leadership skills and/or digital entrepreneurship. Several other prior studies have looked into the potential for e-jobs in Luxembourg (Fedil, ABBL, & CLC, 2014; FEDIL, 2012; Gareis, Markus, Dashja, & Stabenow, 2015; Gouvernement du Luxembourg, 2011). These studies developed predictions about expected jobs in terms of numbers and, by doing so, confirmed a high and growing demand for ICT professionals. None of these studies identified current and future specific e-skills or e-competences needs for ICT professionals, and none of them proposed initiatives to develop or acquire these skills. Moreover, many of the above studies relied on secondary statistical data,² which is often collected for a different purpose and carries the risk of being outdated.

Looking at all of the above, it appears that in the particular context of ICT professionals Luxembourg shows signs of a “second level digital divide” (Min, 2010; van Deursen & van Dijk, 2015; van Dijk, 2006). Therefore, in this paper, we address the question about what specific e-skills and ICT job profiles are needed today and in the foreseeable future in order to support the economic growth of Luxembourg’s ICT sector. To explore this question, we adopt a qualitative approach. Building on our initial study about the strengths and weaknesses of the ICT sector in Luxembourg (Binsfeld, Pugalis, & Whalley, 2015), we conducted a second explorative qualitative study focussing on e-skills for ICT professionals and collected new empirical evidence through direct engagement with actors in charge of human resources from a sample of companies. The outcomes of this second study are presented here. We identify, using the conceptual framework of the e-competences model developed by the EU commission (European Committee for Standardization (CEN), 2014b, 2014c), different e-skills and families of jobs which interviewees perceived to be particularly important. To the best of our knowledge this is the first time such a study has been performed in the context of Luxembourg. We intend to provide a contribution to stimulate the debate about the second level digital divide amongst policy makers, education and training providers and companies not just in Luxembourg but also in similar economical or geographical contexts.

The rest of this paper is divided into 4 sections. Section 2 presents and discusses some of the general frameworks in terms of e-skills, e-competences and digital jobs and presents the growing demand for e-skills at international level. Section 3 introduces the methodology applied and then presents the outcome of our empirical work in terms of job families, ICT competences and training offer in Luxembourg. Section 4 summarises the outcome of this empirical research and suggests policy initiatives which could help to address the situation. Section 5 provides some overall conclusions and suggestions for further actions and research.

² See for example the list page 15 in (Gareis et al., 2015)

2. Digital Competences, e-skills and ICT professionals

There is some uncertainty in literature about what actually constitutes an e-skill or e-competence and what is meant by digital competences (Ant, Goetzinger, & Binsfeld, 2016). Consequently, definitions remain fluid and contested, and there is no widely accepted notion 'e-skills'. The purpose of this section is to present different definitions and to introduce the conceptual framework which has been used to analyse the data.

According to Ilomäki, Paavola, Lakkala, & Kantosalo (2014), e-skills encompass a wide range of ICT related elements such as knowledge, skills, abilities, attitudes, performances and must be seen in a wider perspective of social and managerial skills. They systematically reviewed at a total of 76 different studies and suggested that digital competence can be defined as consisting of four components:

- (1) technical competence;
- (2) the ability to use digital technologies in a meaningful way for working, studying and in everyday life;
- (3) the ability to evaluate digital technologies critically; and
- (4) the motivation to participate and commit in the digital culture.

Along similar lines, the European Commission proposes a comprehensive model for a definition and hierarchy of e-skills according to three different proficiency levels (McLaughlin et al., 2014):

- ICT user skills/digital literacy - skills that are fundamentally necessary for the effective use and application of common ICT systems, devices and software tools in support of their own work and their personal interests. Broadly speaking, these cover the term 'digital literacy', which refers to the confident and reflected use of ICT for work, leisure, learning and communication.
- ICT practitioner skills - skills that are necessary for researching, designing, developing, planning strategically, managing, producing, consulting, marketing, selling, integrating, installing, administering, maintaining, supporting and servicing ICT systems.
- E-business/E-leadership skills - these refer to the abilities needed to exploit strategic opportunities by using ICT technology (especially the Internet), to assure stronger performance of organizations and to research capabilities for new ways of improving or implementing business, administrative and organizational processes. E-business skills are linked to strategy and innovation, and contain in addition a significant part of generic, i.e. non-sector and non-ICT specific skills.

This paper will focus exclusively on ICT professionals, which can broadly be located in the ICT practitioners and E-leaders categories identified above. Again there is some uncertainty what is actually meant by an ICT professional – see, for example, Thompson (2008) who argues that the profile and the role of an ICT professional has evolved dramatically over time and is likely to further evolve in the future. Agresti (2008), therefore, argued that a “body of knowledge” would be required to come up with a more precise definition of the ICT profession.

Building on this idea, the EU commission proposed such a “foundational body of knowledge” (Veling, Murnane, O'Brien, & McLaughlin, 2013) in order to establish “a common language” and “a shared understanding”, at least at the EU level, of what constitutes an ICT professional. As part of this initiative, they also developed a “European e-competence framework”, which suggests 36 ICT competences and five proficiency levels with the aim of providing more

transparency regarding ICT competences across organisations and countries (see Figure 1 below).

A wide range of similar frameworks have been developed such as, for example, the skills framework for the information age (SFIA)³, the information security skills framework (IISP)⁴, the “référentiel de compétences TIC du collectif genevois (Collectif genevois pour la formation de base des adultes, 2015), the conceptual framework for digital competences (Ferrari, Punie, & Brečko, 2013) or the framework developed by Canada’s Association of IT Professionals (Information and Communications Technology Council, 2014). All of these models identify broadly similar job roles than the ones mentioned in Figure 1. In parallel, Ferrari, Punie, & Brečko, (2013) have also developed a model for digital literacy and digital competences which are increasingly required by the general public a part of their day-to-day lives. This model covers the following five areas: information processing, communication, content-creation, problem-solving and safety. It is, however, less suitable for ICT professionals because it focusses on the usage of ICT by the general public.

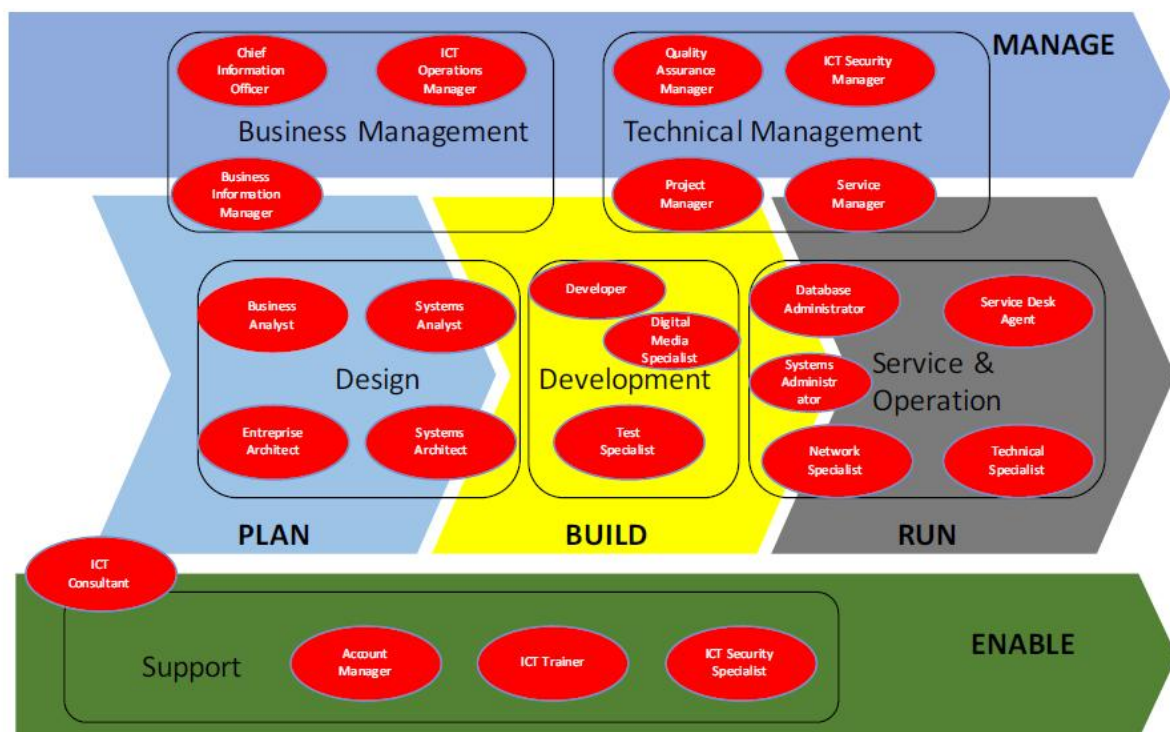


FIGURE 1 - STRUCTURE OF EUROPEAN ICT PROFILES (SOURCE: CEN)

Generally speaking these models tend to be very similar and given the specific context of Luxembourg, we have focussed in the following on the use of the EU e-competences framework⁵. Based on the European ICT Professional Profiles, the e-Competence Framework provides a reference of competences for ICT professionals, using a common language for competences, skills and proficiency levels that can be understood across Europe. It was created for application by ICT service, user and supply companies, for managers and human resource (HR) departments, for education institutions and training bodies including higher education, for market watchers and policy makers, and other organisations in public and private sectors.

³ See <http://www.sfia-online.org/en> accessed 2.7.2016

⁴ See www.iisp.org accessed 2.7.2016

⁵ This framework has also be used by the authors to analyze the qualitative data collected during their research process

It has been widely documented, there is a wide range of material available to explain how it can be applied and it has been standardised by the European Committee for Standardization, (2014a, 2014b, 2014c)⁶.

3. What specific e-skills are needed for Luxembourg's ICT ecosystem now and in the foreseeable future?

3.1. Methodology

As mentioned above, we collected in a first step primary data by conducting a set of 51 interviews with stakeholders active in the local ecosystem, obtaining in the process their views about the strengths and weaknesses of the ICT Ecosystem in Luxembourg (Binsfeld et al., 2015). This initial study did confirm the findings from previous research as many interviewees complained about the missing “entrepreneurial mind-set”, the lack of professional e-skills and a growing second level digital divide. It was not possible, however, to identify in detail what specific e-skills were needed as we talked at this stage to CxO level stakeholders rather than to heads of human resources or officers in charge of recruitment. Therefore, we carried out a second qualitative and explorative analysis building on semi-structured interviews with mainly Heads of Human Resources in order to collect their views about the different job profiles that might be relevant for Luxembourg.

According to Luxembourg's statistical office (Statec, 2012), there are nearly 1,800 companies active in the ICT sector in Luxembourg. About 91% of these are very small with less than 10 employees and 62% are one man businesses. About 150 companies employ between 10 and 20 employees and another 130 between 20 and 250 employees whereas only 4 companies employ more than 250 people (of which the publicly owned telecommunications incumbent operator represents the biggest one)⁷. Taking this industry structure into account, we identified a sample of 20 interviewees with representatives from the 4 biggest players but also including representatives from the one man companies in order to conduct the interviews.

The main objectives of our interviews was to collect opinions and views about the following issues: what are the most relevant technological trends that affect e-skills, what are the perceived most relevant and job profiles, what levels of qualification, certification, education and training are most looked for, is previous experience important, why is there not more local supply of workforce, which are the countries of residence of existing workforce and what are the perceived future needs in terms of jobs and qualifications. All interviewees were briefed by telephone and received a written list of questions (interview guide) before the interview so that they were able to prepare themselves and collect the necessary information within their organisations.

In terms of introduction and before actually discussing the specifics of e-skills and job roles, interviewees were asked what they perceived as the technological trends that could have a major influence on their respective organisations and indeed the whole ICT ecosystem in the short and medium term. The following trends were identified by the interviewees:

- mobility and mobile application technologies
- growing importance of social media for both private and business purposes.
- cloud computing
- big data analytics

⁶ More information on e-CF and alternative competences models and their application can be found for example in Ant et al., (2016)

⁷ More information about the structure of the ICT ecosystem can be found for example in Krylova, (2015) or in (Service des Médias et des Communications, 2013)

- the Internet of things (IoT)
- IT security

This is very much in line with many recent studies identifying and examining technological trends. Indeed, the same topics are mentioned in, for example, Accenture, (2015); Deloitte, (2015); European Schoolnet, (2015), IDC (2014) and Robinson, Hendricks, Hanny, Korte, & Hüsing (2015).

Interviews generally lasted around 40 minutes and the responses were noted down directly into the interview guide and their correctness of these notes validated with interviewees. The outcome of the interviews was analysed using the e-competences framework mentioned – see Figure 1.

To conclude the process and develop a deeper understanding of the results, three prospective workshops were organised with a subset of the interviewees mentioned above. The objective of these workshops was to identify potential initiatives and specific actions that might help to improve the situation. Workshop participants were asked to brainstorm and discuss what according to them should and/or could be done⁸. The outcomes were then discussed with a wider range of stakeholders in order to draw general conclusions towards identifying what specific e-jobs and digital competences would actually be required. In addition, we also conducted a summary of the ICT training offer in Luxembourg in order to establish a high-level inventory of local initial and vocational training offers for the ICT sector with the objective examine whether the current training offer actually corresponds with the skills sets required.

3.2. Empirical findings from the interviews

The outcomes presented here should be considered taking into account the fact that the specific situations of the different companies interviewed could vary substantially. A one-man company has different recruitment needs than one with say nearly 1,000 highly qualified and specialised ICT professionals. The opinions expressed in terms of job profiles have been related to the e-competences framework in Figure 1. They have then been cross-checked with the findings of the recent study by the local business federation mentioned above⁹, which builds on a much larger and different sample size (Fedil, ABBL, & CLC, 2016). This process allowed to identify six families of e-jobs which are considered as being the most relevant for the Luxembourgish ICT sector. These are:

- Jobs related to marketing, communication and business intelligence
- Jobs related to IT management, quality, testing and security, technical oriented profiles related to infrastructure and network management
- Jobs related to IT governance and IT project management
- Jobs related to user assistance and support
- Jobs related to design, development and maintenance of software and applications.

As shown in Table 1 these families of jobs were felt relevant by many of the participants, although their activities and sizes show a great variation. Considering the technological trends mentioned above, most interviewees agreed that demand for the identified job profiles was likely to further increase in the coming years. This observation was verified by two local recruitment agencies specialising in ICT jobs in Luxembourg

⁸ A summary overview of some potential initiatives is provided in appendix

⁹ The lead participated in this study as a representative of his organisation

Compai	Employees in Luxembourg	Main activity	Marketing, Communication and Business Intelligenc	IT Management, quality, testing and security	Infrastructures and networks	IT Governance and Project Management	User Assistance and Support	Software development and maintenance
1	1500	E-commerce	X	X	X			X
2	200	Research and Development	X					
3	30	Web and Online Marketing	X					X
4	30	SAP integrator	X		X		X	
5	5	Cybersecurity		X	X	X	X	
6	5	Web design			X			X
7	5	Cybersecurity		X			X	
8	5	Digital Marketing	X					X
9	5	Software Development		X				X
10	15	IT maintenance services	X		X		X	
11	15	IT infrastructure and cloud services		X	X	X	X	X
12	3000	Telecom incumbent	X	X	X			
13	50	IT Consulting	X		X	X	X	X
14	500	International media company	X		X	X		X
15	500	Satellite operator		X	X		X	
16	30	IT Project Management		X			X	
17	300	Software Development	X	X	X	X	X	X
18	30	IT Consulting		X	X	X	X	X
19	300	ICT Integrator		X	X		X	
20	20	VoIP equipment provide	X	X	X		X	X

TABLE 1 - JOB PROFILES MENTIONED IN INTERVIEWS

Interviewees reported that many of their employees had followed, in terms of their formal education, a technically oriented curriculum in computer science and nearly all of them have acquired their qualifications outside of Luxembourg. Qualifications were obtained either within the greater region (France, Belgium, Germany) or further afield (Switzerland, UK or USA). In terms of the required formal qualification levels, it was reported that only a low number of job roles can be fulfilled with a qualification level below at least two years of university studies. A clear majority said that for them, Bachelor of Science and Master of Science level qualifications would be the most relevant.

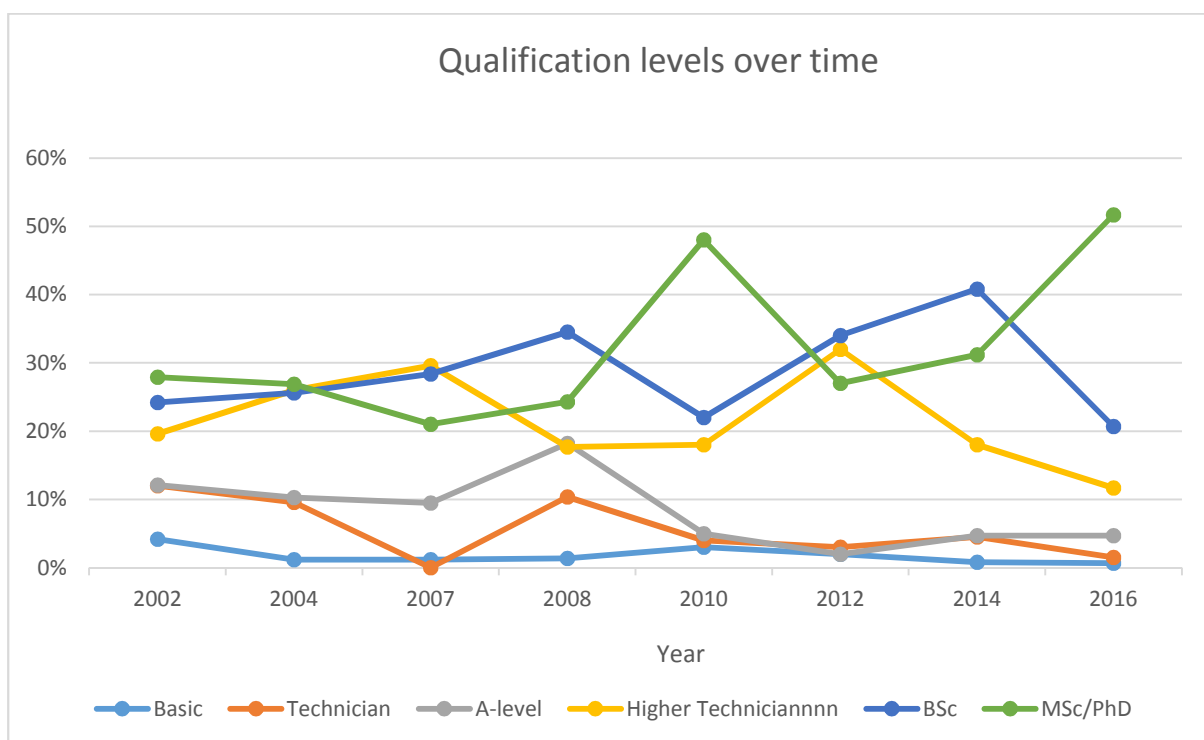


FIGURE 2- QUALIFICATION LEVELS OVER TIME (SOURCE: FEDIL)

Again these findings have also been confirmed in the quantitative study of Fedil, ABBL, & CLC (2016). They found that the qualification level of skills needed appears to be increasing between 2002 and 2016 and that there is now a growing demand for Bachelor, Master and even PhD level qualifications (see Figure 2).

In terms of nationalities, a lot of the existing workforce appears to be of French or Belgium extraction and these employees tend to reside in their respective home countries and commute to Luxembourg on a daily basis. Figure 3 (below) presents an overview of some of the comment made regarding this issue by interviewees. It confirms some of the difficulties that employers face when trying to recruit the necessary job profiles. Apparently, the country is not able to produce its ICT professionals locally.



FIGURE 3 - AN INTERNATIONAL WORKFORCE

Perhaps this can be partially explained by the fact that there also appeared to be little formal local training and education opportunities for the respective e-jobs and Luxembourgish natives do not seem to be attracted by jobs in ICT¹⁰. Interviewees mentioned their growing difficulties to attract potential candidates to Luxembourg and keep them motivated to stay there. The interviewees also sometimes identifying the fact that French as the predominant working language would limit their choices with respect to whom they could recruit.

Participants also highlighted the importance of previous working experiences and vocational training given the very rapidly evolving technical and regulatory environment. Work experience was felt to be of importance but companies are also prepared to recruit directly from

¹⁰ A representative of the Ministry of Education indicated to the lead author recently that only about 130 students each year are prepared for a potential career in ICT

school or university as very often it is difficult or impossible to attract experienced people. Many interviewees reported that they recruited junior staff and that substantial investment were made into the continuous vocational education and training of these junior recruits. The difficult then resides in keeping these people on board due to the high competition between employers. Some also mentioned issues related to experienced people leaving companies for sometimes better paid and more secure jobs within the public sector. Figure 4 presents the details of some comments collected about working experience and vocational training.

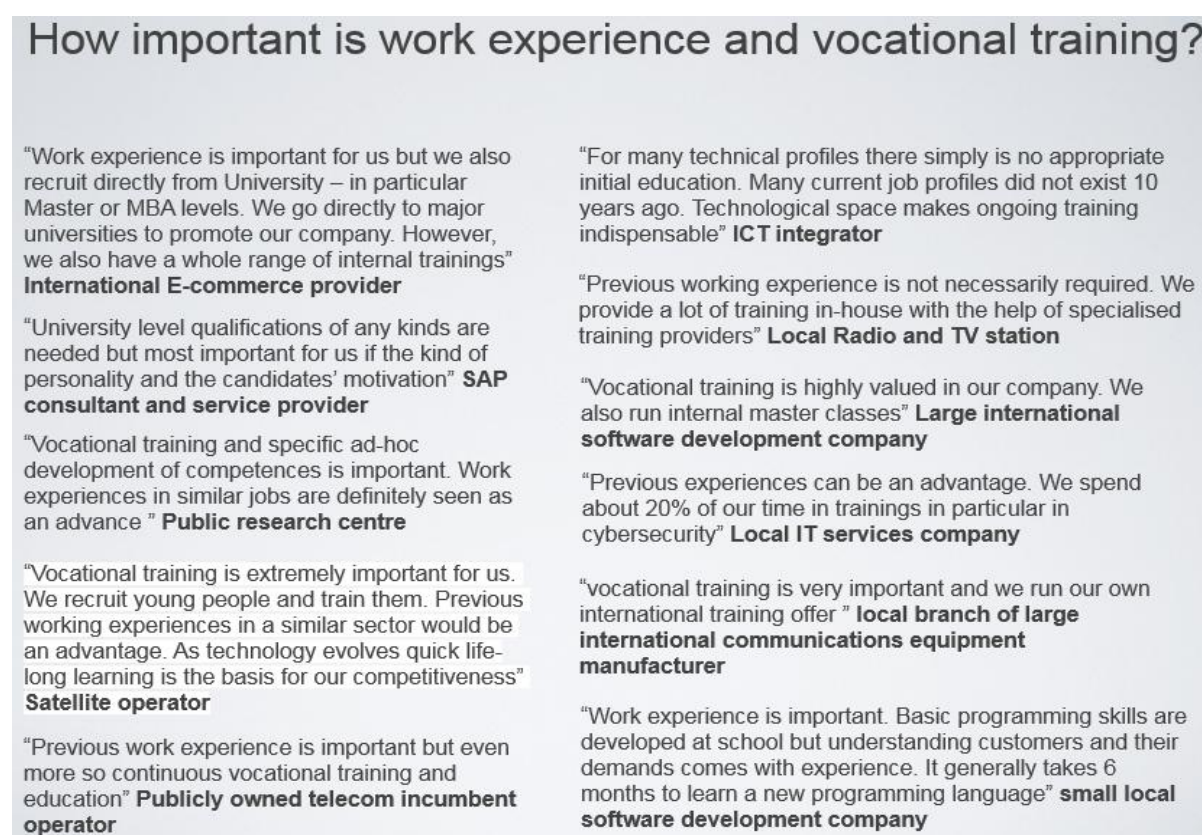


FIGURE 4 - WORK EXPERIENCE, VOCATIONAL AND FORMAL EDUCATION

When asked which profiles interviewees had the most difficulty to find the relevant skills and resources the following comments, as shown in Figure 5, were made. Given the variety of activities of the different companies in the sample, a wide range of job profiles has been mentioned and no clear priorities emerged. There was however, again a link to the technological trends identified above. Thus, this question was further debated with a subset of interviewees as part of exploratory workshops.

What are the most difficult to find profiles?

“For us it is supply chain managers and generally people interested in e-commerce, fluent in English and willing to move to Luxembourg with their families” **International E-commerce provider**

“SAP consultants are most difficult to find even if you offer very attractive packages” **SAP consultant and service provider**

“Project managers with both technical and management skills at an academic level, PhD candidates and Post-Docs” **Public research centre**

“We are in an international competition in our specific industry and we have to compete locally with the public sector. We do experience difficulties to attract people to Luxembourg” **Satellite operator**

“Online and digital marketing specialists, SEO specialists, social media experts and web project manager. We have to use freelancers” **Digital Marketing consultant**

“Cloud Architects, engineers and administrators, Help desk operators. There is an intense competition between employers to attract and keep talents” **Publicly owned telecom incumbent operator**

“For us it is e-journalists which are most difficult to find and in particular if they have to speak Luxembourgish in addition. The local educational system does not provide any education in that respect” **Local Radio and TV station**

“Content management, Business intelligence, IT transformation. We have no problem with employment conditions as we offer attractive packages” **Large international software development company**

“IT consultants, it is nearly impossible to find the right profiles in the local market and even in the greater region. Our recent hires come from Marseille and Lyon” **local branch of large international communications equipment manufacturer**

“Security consultants, IT developers, Security Engineers, Senior researchers” **Local IT services company**

“PEN testers, network engineers – we offer “too good” employment conditions” **Local IT services company**

FIGURE 5 – JOB PROFILES MOST LOOKED FOR (2015)

3.3.Exploratory workshops and brainstorming sessions

During these exploratory workshops, participants brainstormed about the types of competences they felt to be most relevant to them and identified three groups of competences:

- key competences that were felt being absolutely necessary;
- important competences that were felt necessary; and,
- “nice-to-have” additional competences.

Obviously, this table is based on a limited subset of companies, though all of the larger actors directly participated in the workshops. It is interesting to observe that none of these competences is directly linked to technical skills. Workshop participants felt that the technical skills can be provided “on-the-job” or via vocational training as long as employees possess a sound basic technical understanding. Some of the human and social skills listed in Table 2 are, however, more difficult to acquire through training or education.

Key Competences
Good written and oral communications skills Innovative and creative mind-set Generate and understanding strategic visions Identify and understand stakeholders needs Being able to work autonomously Being flexible, multi-disciplinary Knowing about norms and standards Good language skills (at least 2 different one) Emotional intelligence Being able to take decisions Problem solving capabilities
Important Competences
Being able to sense and understand the main technological trends and evolutions Working in teams Negotiating capabilities Understanding budgets and financial issues Having an analytical mind Being able to manage and drive change Application development skills Project management skills Safety, security and risk management competences Self-marketing skills
Complementary Competences
Basic understanding of legal aspects Leadership skills Basic understanding of digital marketing techniques Being productive

TABLE 2 - DIFFERENT LEVELS OF COMPETENCES

Participants were also asked to comment on what they felt might be the main underlying reasons for these missing competences and what they felt they could do about and the following present some of the comments which were made. As can be observed from Figure 6, there was some consensus that the local university did not yet offer a curriculum that completely matches the needs of the local ICT sector. As a result, a lot of the training available was coming from outside Luxembourg. There was some disagreement about the importance of technical versus social skills – some participants felt that there was too much focus on technology whereas other were of the opposite opinion.

What are the main reasons for missing competences?

"Our company is not well known. Luxembourgish candidates don't find us and they generally do not possess necessary competences and even less so relevant experiences" **International E-commerce provider**

"The local training offer (formal, informal, vocational) is not appropriate, in particular for SAP specialists, cloud services and new technologies but also in terms of personal development topics" **SAP consultant and service provider**

"The local university is too young and not offering yet the "right" trainings, skills and competences for the local economy. There is an important lack of language skills as well – in particular in terms of English" **Public research centre**

"We don't know and care about the underlying reasons. We just live with the situation and take matters on hand ourselves" **Satellite operator**

"lack of creativity, trainings in creativity, basic economics and team working skills" **Large international software development company**

"The curriculum at university is not completely in line with our current requirements. There is too much focus on technology. Social and human skills need to be more developed, just as the capacity to work in teams. It is also important to promote ICT related jobs amongst young people and their parents" **Publicly owned telecom incumbent operator**

"Schools have difficulties to follow the technological pace of change but sometimes even the basics are missing. There is too much focus on some proprietary solutions." **local branch of large international communications equipment manufacturer**

"Previous experiences can be an advantage. We spend about 20% of our time in trainings in particular in cybersecurity" **Local IT services company**

"University curriculum is not in-line with the demands of the local economy. There is too much focus on technical skills, More project work is needed rather than formal teaching. Social skills such as team working and project management are also required" **small local software development company**

FIGURE 6 - PERCEIVED MISSING COMPETENCES

3.4. Education and training offers

Taking into account the aforementioned comments regarding the lack of appropriate training and education offers, we also examined the relevant training programmes available in Luxembourg and within in the greater region both in terms of formal qualification programmes as well as vocational education and training based on specific certifications. Both the initial education as well as vocational training and education are relying to a large extent on offers available in the surrounding countries.

These findings are supported by OECD who concluded that enrolment rates for higher education in Luxembourg are relatively low, and that a lot of importance and time is devoted to language teaching (OECD, 2014). This, however, is a direct consequence of Luxembourg's smallness, its reliance on foreign workforces and the necessity to speak at least three or four languages. OECD also comments that the ratio between teachers and students is very low and that Luxembourg's budget for education is relatively high in comparison to other OECD countries. In another OECD study focusing on Luxembourg's innovation policy (OECD, 2015), it was found that, although there is a local university and several public and private research centres, these are not actively helping to address the lack of STEM competences. European Schoolnet and University of Liège in particular have looked into the use of ICT in education in Luxembourg as part of a EU wide study (European Schoolnet, 2012) and identified the good availability of equipment and infrastructure, but a below average use of this equipment and a serious lack of confidence of using digital technology among both students and teachers.

If we critique the available education and training offers, we can make the following observations:

- For the jobs related to marketing, communication and business intelligence – there is nearly no training offer available in Luxembourg, nor in the greater region, except for 'pure'

marketing courses. The IT component in these courses is largely missing just as the business intelligence (data scientists, data analysts etc.) based on “big data” technologies is nearly inexistent.

- For jobs related to IT management, quality, testing and security, a wide range of trainings and education programmes are available (Institut Universitaire International Luxembourg, 2014). However, due to the rapid technological changes to be expected in this area it is important to constantly adapt the training offer to the needs of employers and those being trained.
- For jobs related to infrastructure and network management there is a wide range of trainings available which probably will have to evolve and focus more on “cloud computing” in the future.
- For jobs related to user assistance and support, interviewees perceived a substantial lack of available training. Much of what is available is provided directly by hardware or software vendors often outside of Luxembourg.
- For the jobs related to software development, there is a wide range of trainings, often at an international level, available. A wide range of trainings are offered as on-line, self-study modules. Luxembourg does not offer any local certification related to ICT, all certifications are “imported” from outside of Luxembourg. However, there are some local test centre facilities available.

Given the quickly evolving technological environment, vocational training and life-long learning is particularly important to e-skills. In that respect, interviewees felt that more could be done to communicate the existent training programmes and offers to interested parties. This was also confirmed through discussions with additional stakeholders by Ant et al (2016). Quite simply, there appears to be a lack of information regarding the available training and education offers so far. Ant et al. (2016), therefore, propose the creation of “virtual” ICT centre of competences that would whose mission would be to establish an inventory of the existing offer and provide some kind of a matching tool between this offer and the perceived training needs of companies and individuals.

Furthermore, it was felt that not enough young people (and their parents) know about e-jobs and their potential as a successful future career choice. This was also observed in a study conducted by the local business federation (Fedil et al., 2016), with the authors of this study establishing a dedicated web site in order to contribute to raising awareness¹¹.

Interviewees also mentioned that all involved stakeholders - employers, the different sector representatives, different government agencies as well as the media - would have to intensify their efforts in order to promote the ICT sector.

3.5. Recruitment needs and training priorities

Building on the findings above, participants during the prospective workshops identified different specific job profiles and classified these in terms of both recruitment priority needs and training needs. These needs are summarised in Table 3 (below). This table is based on a limited number of companies, though all of the larger players in Luxembourg participated directly in this workshops.

Less critical jobs profiles – low recruitment needs – low training needs	Business dependent job profiles – high recruitment needs – lower training needs
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¹¹ See [www. http://www.tic-tonjobdavenir.lu/](http://www.tic-tonjobdavenir.lu/) accessed 13.8.2016

Project Manager, E-journalist, Graphical Expert, Telecommunications Engineer, IT Manager, CIO, Data Security Engineer, Online Marketer, Web Designer	Social Media Administrator, Social Media Consultant, Social Media Operator, 3D Designer, Programmer (C, C++), Maintenance Engineer, Maintenance Technician, Software Developer, Helpdesk Technician, IT Technician, IT Administrator, Network Administrator
Technological jobs profiles – high training needs	Critical job profiles – high recruitment needs – high training needs
Bioinformatics, Security researcher, ERP consultant, IT trainer/consultant, SaaS consultant, Strategic coordinator, Change and Innovation manager, E-services managers, IT Engineer, Network Engineer, Systems Engineer, Penetration Tester, Internet of Things Specialist, Transition Manager, Video Specialist	Cloud Architect, Cloud Engineer, Cloud Orchestrator, Cloud Technical Product Manager, Cloud Consultant, Cloud Administrator, Security Engineer, Security Consultant, Business Intelligence Analyst, Data Analyst, Data scientist, Legal Experts, Systems Architects, Technical Sales People, Virtualisation Consultants, Application Designer, Application Developer

TABLE 3 - DIFFERENT GROUPS OF JOB PROFILES

In particular, the argument has been compiled with the inputs of the four most important players within the ICT ecosystem in Luxembourg. Four categories of jobs were identified in terms of their perceived business importance, the level of additional training offer and the needs that participants felt would be required. These most critical job profiles are in line with the general technological trends noted above, and in this respect Luxembourg is no different from other countries.

4. Discussion – a second level digital divide and what can be done about it?

The empirical work outlined in the previous main section provides evidence that Luxembourg does indeed suffer from a second level digital divide in terms of professional e-skills. In general, there are not enough ICT professionals available. More particularly, the specific six families of job profiles identified above are not available in sufficient numbers. Young people appear not to be very motivated and interested in working in the ICT sector, or they fail to receive information about its potential. Our research has highlighted an under provision of local educational education and training programmes in Luxembourg and is line with a recent study conducted by Empirica for the EU commission (Gareis, Markus, Dashja, & Stabenow, 2015). On the other hand, the e-skills issue is not very high on Luxembourg's policy agenda, which seems to focus more on the development of the underlying infrastructures (Binsfeld et al., 2015)

In order to address this situation, Luxembourg has so far largely relied on attracting talented individuals from outside the country, especially from the greater Luxembourg region (Digital Lëtzebuerg, 2016; Thibaut, 2016). This source appears to be declining and thus may not be sustainable, and leads to strong competition between employers when seeking to recruit talent. This, in turn, leads to increased wages as documented by, for example, Hays (2016). These high salary levels lead in turn to a reduced overall productivity and potential competitive disadvantages internationally in terms of jobs related to software and application development. As an outcome of the interviews and the prospective workshops, it became apparent that a changed approach is needed involving all stakeholders and involving action on several different

levels including both public (different Government administrations and ministries) as well as private actors (companies, industry associations and private training and education providers).

In terms of the existing training offers it is necessary to gain a better understanding of the training needs of companies and the public sector, and to establish better communication and collaboration between training organisations (both public and private) and actors within the ICT ecosystem by, for example, conducting regular enquiries on the skills needed, setting up regular information exchanges with ICT organisations and sector representative such as ICTLuxembourg (Gaudron, 2014a; ICT Luxembourg, 2015; Le quotidien, 2015).

The local training offer needs to change. It needs to become more versatile and include social, business, entrepreneurial and managerial dimensions. The training also needs to become more flexible, focussing on individual competences and certifications rather than diplomas. The training should also be practically orientated and directly applicable to the marketplace and the requirements of the whole economy. Of particular importance is the need to develop training that targets cloud computing, IT security and big data.

Formal initial education, both at elementary and secondary school levels, might integrate far more extensively and far better ICTs as a subject matter but also as means to address problems and support pedagogically other subject matters (Thibaut, 2016). However, this will clearly take time to implement. In addition, new ways of training might be explored - for example, the MOOC's as part of a blended digital learning curriculum, or "serious games" (Derryberry, 2007), which are already used in France among other countries¹². Coding schools might constitute another interesting alternative, and are currently being introduced into Luxembourg (Luxemburger Wort, 2016). Other alternative training and learning formats could include mentoring, coaching, combining school and job, and training on the job as well as peer-to-peer networks. All of the later could potentially be implemented quite quickly if all stakeholders combine their efforts, but will not lead to formal qualifications which can be offered only by the formal educational sector.

A major change is also needed in terms of moving towards a more collective effort by the learners, the trainers and training institutions, employers, the academic actors and policy makers in order to attract more students to ICT and develop the available training. All of these stakeholders need to become more aware that it is in their common interest to develop e-skills. An interesting initiative in that sense could be the establishment in Luxembourg of a "National Coalition for e-skills", which was both suggested and has been supported by the EU commission (EU, 2013; European Commission, 2015d). Such a national coalition could act as a platform for discussion and information exchange between different stakeholders and their representative bodies. A first meeting of such a coalition has already taken place (March 2016), and a further meeting is scheduled to occur in the autumn.

Cross- or inter-disciplinary learning needs to emerge. A managerial dimension could be incorporated into 'conventional' IT training, and IT included into vocational education and training. Several vocational training providers, who are supported and financed by the Chamber of Commerce and the Chamber of Crafts, have recently announced the creation of a "virtual ICT centre of competences" in order to address this issue (Zabatta, 2015). As these new curricula emerge, trainers and educators will also have to develop their own skills in information security and skills related to the practical use of different new technologies. They need to evolve into learning facilitators and co-builders (or even co-learners) of knowledge. Trainers and educators also need to be more open and prepared to be assessed and challenged

¹² see <http://www.cigref.fr/sensibiliser-a-la-cybersecurite-le-serious-game-cigref-dans-les-entreprises> accessed 14.12.2016

on their performance (OECD, 2013). Their new training methods may include for example games, programming or entrepreneurial approaches. The preferred educational formats might become coaching and mentoring rather than formal teaching. In that respect several training organisations have recently cooperated to launch a specific “train the trainers” training offer (Thelen, 2016).

Companies have also their share of responsibility in training their current and future employees. To further develop e-jobs skills, stakeholders might unite more to develop a pool of e-jobs skills in Luxembourg. Similarly, cooperation between private and public sectors seems essential for the development of such a pool in Luxembourg. Employers might contribute more to the development of training modules and thus support the development of the economy and the employability of graduates. Some larger international actors such as Cisco, HP or IBM have recently expressed¹³ their interest to establish local training centres. One can, of course, reflect about what the objective of these actors really is? Helping to address the situation in Luxembourg, or trying to promote their technology solutions in order to promote their sales.

As the focus is increasingly placed on the creation of expertise within a specific business environment, companies must ensure the practicability of trainings to the specificities of the the Luxembourgish ICT sector’s and its economy, and enable the development of skills on the job through internships or other immersions in the business context. In that respect it is interesting to point out that both the Chamber of Crafts and the Chamber of Commerce as well as the banker’s association have established new vocational training institutes in 2015 (Adam, 2015; Couset, 2016; Osorio-König, 2015; Schmit, 2015).

All of these suggestions imply that the learners, the teachers and educators, the employers and policy makers feel jointly responsible for improving the quality of existing training and developing new initiatives. Stakeholders would need to invest collaboratively and to apply themselves in the design and realisation of new skill sets and trainings involving technical competences, social and behavioural competences, managerial and business competences, new training and education formats. Better collaboration between all stakeholders is thus required in order to contribute to further strengthening the ICT ecosystem in Luxembourg. This, however, currently proves to be difficult as there is no entity or platform, neither on the public nor on the private side, that could play the role of facilitating communication and coordination between the different stakeholders. In that respect be noted that the Government recently launched the “Digital Lëtzebuerg” initiative (Antzorn, 2014; Gaudron, 2014b; Gouvernement du Luxembourg, 2014). This initiative also set up a working group on e-skills albeit without a specific agenda or budget.

5. Conclusions and future research

The ICT sector is important for Luxembourg’s economy and this has been widely acknowledged by public and private actors (Kitchell, 2010; Luxembourg for Business, 2013a, 2013b; PWC, 2011). Many efforts have been made to support the development of the sector, in terms of its infrastructure and legal or regulatory environment. This has allowed Luxembourg to be competitive and thus become well positioned in international league tables (European Commission, 2015a; International Telecommunications Union, 2015; World Economic Forum, 2015). ICT are also widely used by the general public; fixed and mobile high speed internet access is available to nearly 100% of the population (Frising, 2013).

¹³ In direct discussions with the lead author

However, these efforts are not enough and risk being lost if Luxembourg does not also address its second level digital divide in terms of ICT professionals.

Through the use of the e-competences framework we have identified some of the underlying reasons of this second level digital divide such as lack of information about the potential of e-jobs, a lack of interest in STEM topics, and the lack of training and education programmes. We also have identified six families of e-jobs which a purposive set of actors from the local ICT sector consider to be most relevant ones now and in the foreseeable future. We also have identified some underlying competences and training needs. We finally have argued for the need of a better communication, coordination and collaboration between the different stakeholders and the need of a single entity to take care of this. Perhaps the establishment of a national coalition for digital jobs (EU, 2013; European Commission, 2015d), as suggested by the EU commission, might be a way forward.

Of course, we have only been able to provide a snapshot at a given moment in time and with a given set of actors, which might be of limited value given the disruptive forces in an extremely quickly evolving ICT environment. We hope nevertheless that our work has helped to raise awareness and to put the second level digital divide topic on the agenda of policy makers, academics and vocational training providers.

Clearly more in-depth research will be necessary on several of the issues identified. For example, there needs to be a better understanding of MOOC's, their availability and how they can be integrated into a learning curriculum. Given the quickly evolving external environment there should also be a continuous monitoring process of professional e-skills needs and availability on an on-going. It would also be interesting to gain a better understanding of the potential implications of the presence of large international ICT players already present in Luxembourg – for example, Amazon, Apple, Cisco and Microsoft – for current and future academic activity at the University of Luxembourg and the curriculum of schools. Quite simply, what does the presence of these companies mean for the job profiles identified given the pace of technological change?

It would also be of interest to extend the scope of the study beyond ICT professionals and to consider the level of general ICT literacy in Luxembourg. A benchmark with other countries could be useful in order to learn how the issue is perceived there, and what initiatives might already have been taken elsewhere that would be of use within Luxembourg.

References

- Accenture. (2015). *Accenture Technology Vision 2015 - Digital Business Era : Stretch Your Boundaries*. London.
- Adam, A. (2015, November 17). Die Strategie der offenen Tür. *Luxemburger Wort*, p. 2015. Luxembourg.
- Agresti, W. W. (2008). An IT body of knowledge: The key to an emerging profession. *IT Professional*, 10(6), 18–22. <http://doi.org/10.1109/MITP.2008.115>
- Ant, M., Goetzinger, P., & Binsfeld, N. (2016). *E-Skills Study - Strategies for the creation of a virtual e-skills training centre in Luxembourg*. Luxembourg.
- Antzorn, F. (2014, June 4). Feu vert pour la stratégie ICT et Digital Lëtzebuerg. *Paperjam*. Luxembourg.
- Baller, S., Dutta, S., & Lanvin, B. (2016). *The Global Information Technology Report 2016 - Innovating in the Digital Economy*. Geneva. Retrieved from http://www3.weforum.org/docs/GITR2016/WEF_GITR_Full_Report.pdf
- Binsfeld, N., Pugalis, L., & Whalley, J. (2015). ICT ecosystems in small countries : an analysis of Luxembourg. In *26th European Regional Conference of the International Telecommunications Society (ITS), Madrid, 24-26 June 2015*. Madrid: www.econstor.eu. Retrieved from <http://www.econstor.eu/dspace/handle/10419/127127>
- Binsfeld, N., Whalley, J., & Pugalis, L. (2015). Competing against yourself: State duopoly in the Luxembourg telecommunications industry. *Telecommunications Policy*. <http://doi.org/10.1016/j.telpol.2015.06.002>
- Bughin, J., Hazan, E., Labaye, E., Manyika, J., Dahlström, P., Ramaswamy, S., & Conchin de Billy, C. (2016). *Digital Europe : Pushing the Frontier , Capturing the Benefits*.
- Collectif genevois pour la formation de base des adultes. (2015). *Utiliser les technologies de l'information et de la communication (TIC)*. Geneva.
- Couset, I. (2016, January). House of Training La maison de la formation continue du patronat. *Entreprises Magazine*. Luxembourg.
- Deloitte. (2015). *Technology, Media and Telecommunications Predictions 2016*. London.
- Derryberry, A. (2007). *Serious games : online games for learning*. *Serious Games*. Retrieved from http://www.adobe.com/resources/elearning/pdfs/serious_games_wp.pdf
- Digital Lëtzebuerg. (2016, June 30). Former plus de ressources ICT au Luxembourg. *Blog Digital Lëtzebuerg*. Luxembourg, Luxembourg. Retrieved from <http://www.digital-luxembourg.public.lu/fr/actualites/e-skills/2016/apsi/index.html>
- Eichler, S., Holzapfel, H., Jenewein, T., Katzky, U., MacDonald, I., Schmidt, M., ... Zimmermann, V. (2016). *Massive Open Online Courses – Hype oder hilfreich?* Berlin. Retrieved from <https://www.bitkom.org/Presse/Presseinformation/Flexible-Weiterbildung-mit-Hilfe-von-Online-Kursen.html>
- EU. (2013, November 8). National Digital Coalition will promote wider use of modern technologies. *EU2013.LT News*.
- European Commission. (2014). *e-SKILLS IN EUROPE Luxembourg Country report*.

- European Commission. (2015a). *Digital Agenda Scoreboard 2015 : Luxembourg*. Brussels.
- European Commission. (2015b). *Digital Economy and Society Index 2015 Country Profile Luxembourg*. Brussels.
- European Commission. (2015c). *Digital Economy and Society Index 2016 Country Profile Luxembourg*. Brussels.
- European Commission. (2015d). *Toolkit for National and Local Coalitions*. Brussels.
- European Committee for Standardization (CEN). (2014a). *Building the e-CF - A Combination of Sound Methodology and Expert Contribution*. Brussels. Retrieved from http://www.ecompetences.eu/wp-content/uploads/2014/02/Methodology_documentation_e-CF_3.0_CEN_CWA_16234-3_2014.pdf
- European Committee for Standardization (CEN). (2014b). *Case Studies for the application of the e-CF 3.0*. Brussels.
- European Committee for Standardization (CEN). (2014c). *European e-Competence Framework 3.0: A common European framework for ICT Professionals in all industry sectors*. Brussels. Retrieved from http://ecompetences.eu/wp-content/uploads/2014/02/European-e-Competence-Framework-3.0_CEN_CWA_16234-1_2014.pdf
- European Schoolnet. (2012). *Survey of Schools: ICT in Education Country Profile Luxembourg*.
- European Schoolnet. (2015). *THE e-SKILLS Manifesto* (2015th ed.). Brussels: European Schoolnet.
- FEDIL. (2012). *Les qualifications de demain dans le domaine des TIC Edition 2012*. Retrieved from http://www.fedil.lu/fileadmin/user_upload/publications/publications/tic.pdf
- Fedil, ABBL, & CLC. (2014). *Les TIC, ton job d'avenir*. Retrieved from http://www.fedil.lu/fileadmin/user_upload/publications/publications/04087_FEDIL_BR OCHURE_ENQUETE_2014_web.pdf
- Fedil, ABBL, & CLC. (2016). *Les TIC - ton job d'avenir - édition 2016*. Luxembourg. Retrieved from <http://www.tic-tonjobdavenir.lu/brochure/>
- Ferrari, A., Punie, Y., & Brečko, B. N. (2013). *DIGCOMP a framework for developing and understanding digital competence in Europe*. (JRC Scientific and Policy Reports No. EUR 26035 EN). Luxembourg.
- Frising, A. (2013). *Regards sur les internautes au Luxembourg et dans l'UE27* (Regards No. Mai 2013). Luxembourg. Retrieved from <http://www.statistiques.public.lu/fr/actualites/conditions-sociales/conditions-vie/2013/05/20130515/index.html?from=rss>
- Gareis, K., Hüsing, T., Birov, S., Budlova, I., Schulz, C., & Korte, W. B. (2014). *E-skills for jobs in Europe: Measuring progress and moving ahead*.
- Gareis, K., Markus, P., Dashja, E., & Stabenow, T. (2015). *e-Leadership Skills for Small and Medium Sized Enterprises Country Report Luxembourg*. Brussels.
- Gaudron, J.-M. (2014a, July 15). ICTLuxembourg : « Une contrepartie homogène ».

- Paperjam*. Luxembourg.
- Gaudron, J.-M. (2014b, October 20). Digital Lëtzebuerg avance ses pions. *Paperjam*. Luxembourg.
- Gouvernement du Luxembourg. (2011). Luxembourg e-skills 2011 repertory. Luxembourg: Gouvernement du Luxembourg.
- Gouvernement du Luxembourg. (2014, June 5). Lancement de la stratégie “ Digital Lëtzebuerg ” par le Conseil de gouvernement des 3 et 4 juin 2014. *Gouvernement Du Luxembourg*. Luxembourg.
- Hays. (2016). *Etude de rémunération Luxembourg 2016*. Luxembourg. Retrieved from http://paperjam.lu/sites/default/files/edr_luxembourg_hays_2016.pdf
- Hüsing, T., Korte, W., & Dashja, E. (2015). *E-skills and e-leadership skills 2020. Trends and forecasts for the European ICT professional and digital leadership labour market*.
- ICT Luxembourg. (2015, May 18). ICTLuxembourg fixe les priorités de travail pour 2015. *AGEFI*, p. 36. Luxembourg.
- IDC. (2014). *ICT TRENDS 2020 Main Trends for Information and Communication Technologies (ICT) and their Implications for e-LEADERSHIP SKILLS*. Brussels.
- Iilomäki, L., Paavola, S., Lakkala, M., & Kantosalo, A. (2014). Digital competence – an emergent boundary concept for policy and educational research. *Education and Information Technologies*. <http://doi.org/10.1007/s10639-014-9346-4>
- Information and Communications Technology Council. (2014). *Highlights of the ICT Competency Profiles framework*. Information and Communications Technology Council (ICTC). Retrieved from http://www.ictc-ctic.ca/wp-content/uploads/2012/06/ICTC_CPOFrameworkHighlight_EN.pdf
- Institut Universitaire International Luxembourg. (2014). *Observatoire des compétences - Rapport final de l'étude thématique “e-jobs.”* Luxembourg. Retrieved from <http://www.iuil.lu/uploads/documents/files/e-jobs-rapport-final-light.pdf>
- International Telecommunications Union. (2015). *Measuring the Information Society Report 2015* (2015th ed.). Geneva. Retrieved from http://www.itu.int/en/ITU-D/Statistics/Documents/publications/mis2014/MIS2014_without_Annex_4.pdf
- Kitchell, M. (2010). *Luxembourg as a Center for Online and ICT Business*. Luxembourg. Retrieved from <http://www.investinluxembourg.lu/ict/download-free-reports-page?sid=632>
- Krylova, S. (2015). *The ICT inventory in Luxembourg*. Université du Luxembourg.
- Le quotidien. (2015, April 9). La formation, priorité d'ICTLuxembourg. *Le Quotidien*, p. 5. Luxembourg.
- Luxembourg for Business. (2013a). *LUXEMBOURG and ICT : a snapshot*. Luxembourg. Retrieved from <http://ict.investinluxembourg.lu/ict/luxembourg-and-ict-a-snapshot>
- Luxembourg for Business. (2013b). *Luxembourg's ICT and e-commerce environment 2013 (Q2 update)* (Vol. 2013). Luxembourg. Retrieved from www.investinluxembourg.lu/ict
- Luxembourg for Business. (2014, October). Luxembourg's ICT and E-commerce environment. *Luxembourg for Business*.

- Luxemburger Wort. (2016, January 14). Webforce3 & Fit4Coding - the coding school for Luxembourg's jobseekers. *Wort*. Luxembourg. Retrieved from <http://www.wort.lu/en/luxembourg/webforce3-fit4coding-the-coding-school-for-luxembourg-s-jobseekers-5697c2f90da165c55dc5135f>
- Mateus, A. (2015). *DESI 2015 Digital Economy and Society Index Methodological note*. Bruxelles.
- McLaughlin, S., Sherry, M., Doherty, E., Carcary, M., Thornley, C., & Wang, Y. (2014). *e-Skills: The International dimension and the Impact of Globalisation*. Brussels. Retrieved from http://eprints.maynoothuniversity.ie/5559/1/CT_e_Skills_report.pdf
- Min, S.-J. (2010). From the Digital Divide to the Democratic Divide: Internet Skills, Political Interest, and the Second-Level Digital Divide in Political Internet Use. *Journal of Information Technology & Politics*, 7(1), 22–35. <http://doi.org/10.1080/19331680903109402>
- OECD. (2013). *Teachers for the 21st Century*.
- OECD. (2014, September 9). Regards sur l'éducation 2014: le Luxembourg dans la comparaison internationale. *Gouvernement Du Luxembourg*. Luxembourg.
- OECD. (2015). *OECD Reviews of Innovation Policy Luxembourg 2015*. Paris.
- Osorio-König, S. (2015, November 17). Ausbau der Weiterbildung. *Tageblatt*, p. 21. Luxemboug.
- PWC. (2011). *Luxembourg: an e-hub for Europe Opportunities and actions on the horizon 2015*. Luxembourg. Retrieved from <http://www.pwc.lu/en/information-communication-technology/publications.jhtml>
- Robinson, S., Hendricks, L., Hanny, B., Korte, W. B., & Hüsing, T. (2015). *New Curricula for e-leadership skills*. Bonn.
- Schmit, L. (2015, December 31). Ein kohärentes Ökosystem. *Luxemburger Wort*.
- Service des Médias et des Communications. (2013). *Luxembourg & ICT - a snapshot*. Luxembourg. Retrieved from <http://ict.investinluxembourg.lu/ict/luxembourg-and-ict-a-snapshot>
- Stateg. (2012). *2012 Répertoire systématique: Les entreprises luxembourgeoises*. Luxembourg.
- Thelen, C. (2014, September 11). La compétitivité et les autres dossiers de la rentrée. *Paperjam*. Luxembourg.
- Thelen, C. (2016). Réussir à former et former pour réussir ! Retrieved July 30, 2016, from <http://www.carlothelenblog.lu/2016/07/13/reussir-a-former-et-former-pour-reussir-2/>
- Thibaut, F. (2016, June 30). Une pénurie de profils ICT à résoudre. *Paperjam*. Luxembourg. Retrieved from <http://paperjam.lu/news/une-penurie-de-profils-ict-a-resoudre>
- Thompson, C. (2008). IT professional role today and tomorrow. *IFIP International Federation for Information Processing*, 280, 69–80. http://doi.org/10.1007/978-0-387-09712-1_8
- van Deursen, A. J. A. M., & van Dijk, J. A. G. M. (2015). Toward a Multifaceted Model of Internet Access for Understanding Digital Divides: An Empirical Investigation. *The*

- Information Society*, 31(5), 379–391. <http://doi.org/10.1080/01972243.2015.1069770>
- van Dijk, J. A. G. M. (2006). Digital divide research, achievements and shortcomings. *Poetics*, 34(4-5), 221–235. <http://doi.org/10.1016/j.poetic.2006.05.004>
- Veling, L., Murnane, S., O'Brien, C., & McLaughlin, S. (2013). *Governance Framework for ICT professionalism*.
- World Economic Forum. (2015). *The Global Information Technology Report 2015*. (S. Dutta, T. Geiger, & B. Lanvin, Eds.). Geneva. Retrieved from www.weforum.org/gitr
- Zabatta, J. (2015, November 29). Lancement du nouveau Centre de Compétences Information and Communication Technologies. *Le Quotidien*. Luxembourg. Retrieved from <http://www.lequotidien.lu/economie/un-centre-de-competences-pour-les-tic-en-2016/>

Appendix — some suggested initiatives that could help to improve the situation as identified during the prospective workshops

Initiative	Examples of proposed Actions
Work towards a revision of the teaching curricula to include more IT	<ul style="list-style-type: none"> • Train the teachers how to make best use of ICT • Use IT as to support technical and scientific courses • Use more IT devices (tablets, lap-tops) • Start offering IT related courses at elementary level and provide a better integration of IT courses at higher level education
Promote operational and on the job learning	<ul style="list-style-type: none"> • Promote and facilitate internships • Improve support and supervision of apprentices by better cooperation and collaboration between schools and industry • Set-up formal partnership between academia and industry actors • Promote the use of internships as part of recruitment and selection procedures • Improve matching between interests and skills offered and requested
Use Massive Open Online Courses ¹⁴	<ul style="list-style-type: none"> • Select relevant and appropriate MOOC's and create a quality label • Establish common e-learning platforms e.g.Moodle • Build modular, tailor-made, webinars and/or blended learning offers
Develop a common pool of skills	<ul style="list-style-type: none"> • Raise awareness on employers level about current and future needs • Create opportunities for interactions between ICT and non-ICT profiles • Promote lifelong learning and offer possibilities to move from one profile to another • Promote the development of interdisciplinary learning, vocational training and work projects • Make more use of experienced professionals as trainer
Develop Competence Centres	<ul style="list-style-type: none"> • Coordinate available experts, increase visibility and awareness • Position Luxembourg on the international e-skills map • Encourage the establishment of joint public and private initiatives • Create a catalogue of e-competences and regularly update it • Create and update a training offer allowing to develop these e-competences
Foster entrepreneurial spirit	<ul style="list-style-type: none"> • Create a favourable environment for entrepreneurship • Create a seed-fund

¹⁴ See for example Eichler et al. (2016)

	<ul style="list-style-type: none"> • Attract entrepreneurs to Luxembourg and make them stay • Encourage risk taking • Develop entrepreneurial trainings and support programmes • Build on Luxembourg's regulatory and political advantages e.g. stability, trust, languages
Take advantage of specific legislation impacting the economic development	<ul style="list-style-type: none"> • Strict data protection laws • Financial and operational support via mutualised infrastructures e.g. Technoport • Short distances, quick access to public administrations • Specific laws for cloud offers, e-archiving, electronic signatures, cryptography • Promote Luxembourg and strengthen its reputation, Luxembourg branding
Commitment to customer service	<ul style="list-style-type: none"> • Set-up service platforms • Raise awareness for e-marketing • Create new job profiles e.g. e-government, e-health, webdesign, webmarketing
Consider security as an issue	<ul style="list-style-type: none"> • Promote risk analysis framework (in place already in the financial sector) • Raise awareness for SMEs and support their investments in security • Raise awareness and train final users

TABLE 4 - PROPOSED INITIATIVES AND ACTIONS